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**PATENT APPLICATION  
FOR:**

**METHOD OF INITIALIZING AND USING A SECURITY ASSOCIATION  
FOR MIDDLEWARE BASED ON PHYSICAL PROXIMITY**

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**METHOD OF INITIALIZING AND USING A SECURITY ASSOCIATION  
FOR MIDDLEWARE BASED ON PHYSICAL PROXIMITY**

**CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] This application for letters patent is related to and incorporates by reference United States patent application serial number 10/284,135, titled "DEVICE DETECTION AND SERVICE DISCOVERY SYSTEM AND METHOD FOR A MOBILE AD HOC COMMUNICATIONS NETWORK", and filed in the United States Patent and Trademark Office on October 31, 2002. This application for letters patent is also related to and incorporates by reference United States continuation-in-part patent application serial number 10/662,407, titled "DEVICE DETECTION AND SERVICE DISCOVERY SYSTEM AND METHOD FOR A MOBILE AD HOC COMMUNICATIONS NETWORK", and filed in the United States Patent and Trademark Office on September 16, 2003. This application for letters patent is also related to and incorporates by reference United States patent application serial number 10/662,470, titled "MECHANISM FOR IMPROVING CONNECTION CONTROL IN PEER-TO-PEER AD-HOC NETWORKS", and filed in the United States Patent and Trademark Office on September 16, 2003. This application for letters patent is also related to and incorporates by reference United States patent application serial number 10/662,469, titled "APPLICATION CONTROL IN PEER-TO-PEER AD-HOC COMMUNICATION NETWORKS", and filed in the United States Patent and Trademark Office on September 16, 2003. The assignee is the same in this application and the related patent applications.

## FIELD OF THE INVENTION

[0002] The present invention relates, in general, to communication between devices connected to a wireless communication network. In particular, the present invention is a system and method for launching and controlling secure and non-secure application programs in wireless devices in a mobile ad-hoc communications network.

## BACKGROUND OF THE INVENTION

[0003] Short-range wireless systems have a range of less than one hundred meters, but may connect to the Internet to provide communication over longer distances. Short-range wireless systems include, but are not limited to, a wireless personal area network (PAN) and a wireless local area network (LAN). A wireless PAN uses low-cost, low-power wireless devices that have a typical range of ten meters. An example of a wireless PAN technology is the Bluetooth Standard. The Bluetooth Standard operates in the 2.4 GHz Industrial, Scientific, and Medical (ISM) band and provides a peak air-link speed of one Mbps and a power consumption low enough for use in personal, portable electronics such as a personal digital assistance or mobile phone. A introduction to Bluetooth applications is in Bluetooth Application Developer's Guide: The Short Range Interconnect Solution, Chapter 1, Syngress Publishing, Inc., 2002.

Another example of a wireless PAN technology is a standard for transmitting data via infrared light waves developed by the Infrared Data Association (IrDA), a group of device manufacturers. IrDA ports enable computers, such as a laptop, or devices, such as a printer, to transfer data from one device to another without any cables. IrDA ports support roughly the same transmission rates as traditional parallel ports and the only restrictions on their use is that the two devices must be proximately located (i.e., within a few feet of each other) and have a clear line of sight. A

wireless LAN is more costly than a wireless PAN, but has a longer range. An example of a wireless LAN technology is the IEEE 802.11 Wireless LAN Standard and the HIPERLAN Standard. The HIPERLAN Standard operates in the 5 GHz Unlicensed-National Information Infrastructure (U-NII) band and provides a peak air-link speed between ten and one hundred  
5 Mbps.

[0004] An ad-hoc network is a short-range wireless system comprising an arbitrary collection of wireless devices that are physically close enough to exchange information. Construction of an ad-hoc network is quick with wireless devices joining and leaving the network as they enter and leave the proximity of the remaining wireless devices. An ad-hoc  
10 network also may include one or more access points, that is, stationary wireless devices operating as a stand-alone server or as gateway connections to other networks.

[0005] In the future, the Bluetooth Standard will likely support the interconnection of multiple piconets to form a multi-hop ad-hoc network, or scatternet. In a scatternet, a connecting device forwards traffic between different piconets. The connecting device may serve as a master  
15 device in one piconet, but as a slave device or a master device in another piconet. Thus, the connecting devices join the piconets that comprise a scatternet by adapting the timing and hop sequence to the respective piconet and possibly changing the roles that they serve from a master device to a slave device.

[0006] A Bluetooth device includes, but is not limited to, a mobile telephone, personal or  
20 laptop computer, radio-frequency identification tag, and personal electronic device such as a personal digital assistant (PDA), pager, or portable-computing device. Each Bluetooth device

includes application and operating system programs designed to find other Bluetooth devices as they enter and leave the communication range of the network. The requesting Bluetooth device in a client role and the responding Bluetooth device in a server role establish a proximity link between the two devices. The requesting and responding Bluetooth device use the proximity link and a service discovery protocol to discover the services offered by the other Bluetooth device and how to connect to those services.

[0007] A public key infrastructure (PKI) is a system of digital certificates, certificate authorities (CAs), and other registration authorities that verify and authenticate the validity of each party involved in an Internet transaction. A digital certificate is an attachment to an electronic message typically to verify that a user sending a message is who they claim to be, and to provide the receiver with the means to encode a reply. An individual wishing to send an encrypted message applies for a digital certificate from a CA. The CA issues a signed digital certificate containing the applicant's public key and a variety of other identification data. The CA makes its own public key readily available through print publicity or perhaps on the Internet. The recipient of an encrypted message uses the CA's public key to verify the digital certificate attached to the message, verify that it was issued by the CA, and obtain the sender's public key and identification information held within the certificate. With this information, the recipient can send an encrypted reply. The most widely used standard for digital certificates is X.509.

[0008] Cryptography is the art of protecting information by transforming (i.e., encrypting) the information into an unreadable format, called cipher text. Only someone who possesses a secret key can decipher (i.e., decrypt) the cipher text into plain text. Symmetric-key

systems and public-key systems are broad classifications of cryptography systems. A symmetric-key system (e.g., the Data Encryption Standard (DES)) is an encryption system in which the sender and receiver of a message share a single, common key that is used to encrypt and decrypt the message. A public-key system (e.g., Pretty Good Privacy (PGP)) uses two keys,  
5 a public key known to everyone and a private or secret key known only to the recipient of the message. When John wants to send a secure message to Jane, he uses Jane's public key to encrypt the message. Jane then uses her private key to decrypt the message. Symmetric-key systems are simpler and faster than public-key systems, but their main drawback is that the two parties must somehow exchange the key in a secure way. To avoid this drawback, public-key  
10 systems distribute the public key in a non-secure way and never transmit the private key.

[0009] The problem of secure communication and authentication in ad-hoc wireless networks has been addressed in a paper titled Talking to Strangers: Authentication in Ad-Hoc Wireless Networks by Balfanz et al. The authors present a solution that provides secure authentication using almost any established public-key-based key exchange protocol, as well as  
15 inexpensive hash-based alternatives. The solution allows devices to exchange a limited amount of public information over a privileged side channel, and then allows the devices to complete an authenticated key exchange protocol over the wireless link. The solution does not require a PKI, is secure against passive attacks on the privileged side channel and all attacks on the wireless link, and directly captures the user's intention to communicate with a particular previously  
20 unknown device that is within their physical proximity.

[0010] For wireless devices that communicate in a peer-to-peer ad-hoc network, prior art middleware facilitates inter-application communication by hiding peer-discovery, network formation, application and service discovery, as well as automatic application launching, behind an easy-to-use coherent application programming interface (API). However, since no trusted,  
5 accessible, third party based solution is available, establishing secure communication and authentication is difficult for the prior art middleware.

[0011] Thus, there is a need for a system and method for providing secure communication between selected applications in wireless ad-hoc network devices that rely upon middleware to facilitate inter-application communication. The system and method will provide  
10 the means to implement a security API for application-level access to other security services based on the generated peer-to-peer security associations. The system and method do not require a highly available server or PKI and improve establishment of security by relying on a user to enter a password. The present invention addresses this need.

## SUMMARY OF THE INVENTION

15 [0012] A computer system, method, and computer program product for controlling data communication in an ad-hoc network that connects a wireless device and a nearby wireless device. The method stores an application directory, determines a priority for each entry in the application directory, identifies a selected entry based on the priority, and examines the attributes and security parameters associated with the selected entry. When the security parameters  
20 indicate to use a secure connection, the method establishes a security association to support the data communication by querying a database for an existing security association that will satisfy

the security parameters. When the query is successful, the method reuses the existing security association. When the query is unsuccessful, the method creates a new security association by establishing a privileged side channel to the nearby wireless device, negotiating the new security association over the privileged side channel, and storing the new security association.

5   **[0013]**       The attributes include a device identifier, a role, and control parameters such as an application state and at least one user-defined application setting. The security parameters include an information security objective (e.g., maintaining confidentiality, ensuring integrity, authenticating a party, and protecting against replay or reuse), a cryptography method for attaining the information security objective (e.g., a signature verification service, and an  
10   encryption algorithm), and a level of security. In one embodiment, a bit-string includes the security parameters, a value of the bit-string representing each of the security parameters.

**[0014]**       In one embodiment, to reconnect to a secure connection the method stores a security association between the wireless device and the nearby wireless device when the nearby wireless device enters the ad-hoc network for a first encounter. The method stores a copy of the  
15   security association so that when the first encounter terminates, the method can remove the security association and retain the copy. When the nearby wireless device enters the ad-hoc network for a second encounter, the method establishes a secure connection to the nearby device based on the copy of the security association. In another embodiment, the method establishes the secure connection by searching a connection log to locate the copy of the security association. In  
20   another embodiment, storage of the connection log is on a long-term storage device. In another



embodiment, a user operates a graphical user interface to locate the copy of the security association.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

[0015] The accompanying figures best illustrate the details of the system and method for providing secure communication between selected applications in wireless ad-hoc network devices that rely upon middleware to facilitate inter-application communication. Like reference numbers and designations in these figures refer to like elements.

[0016] Figure 1 is a network diagram that illustrates the interaction of the devices that comprise a mobile ad-hoc communications network, in accordance with one embodiment of the present invention.

[0017] Figure 2A is a block diagram that illustrates the hardware and software components comprising server 110 shown in Figure 1, in accordance with one embodiment of the present invention.

[0018] Figure 2B is a block diagram that illustrates the hardware and software components comprising terminal 120 shown in Figure 1, in accordance with one embodiment of the present invention.

[0019] Figure 3A and Figure 3B are flow diagrams of an embodiment of a process for launching and controlling secure and non-secure application programs in a mobile ad-hoc communications network.

[0020] Figure 3C is a flow diagram of an embodiment of a process for reconnecting a secure application program in a mobile ad-hoc communications network.

[0021] Figure 4 illustrates is a diagram of a window depicting an embodiment of a graphical user interface for reconnecting a secure application program in a mobile ad-hoc communications network.

## DETAILED DESCRIPTION OF THE INVENTION

[0022] Figure 1 is a network diagram that illustrates the interaction of the devices that comprise a mobile ad-hoc communications network, in accordance with one embodiment of the present invention. In one embodiment, the mobile ad-hoc communications network is a Bluetooth piconet that includes one master device and up to seven active slave devices. As shown in Figure 1, piconet 100 includes server 110 and five instances of terminal 120. Server 110 maintains the network clock and is the communication manager for each instance of terminal 120. Server 110 typically initiates an exchange of data with an instance of terminal 120. Two instances of terminal 120 typically communicate through the server 110 however, if two instances of terminal 120 communicate directly, one instance will assume the role of server, or master, and the other instance will assume the role of client, or slave.

[0023] Each device in the mobile ad-hoc communications network will either assume the role of a terminal device or a server device. A terminal device is a consumer of services that a single user operates. A terminal device includes devices such as a mobile phone or PDA. A server is typically a stationary device and only produces services. A server device creates a hotspot around them for using their services. "Hotspot" refers to the radio coverage area

provided by the server device for detecting devices and discovering services offered by the applications hosted in the server. If the server device is not stationary, one of the terminal devices in the network will assume the role of application directory server and perform device detection and service discovery functions for the remaining terminal devices in the network. The disclosed invention introduces two roles among such terminal devices, application directory servers and terminals, where application directory servers serve terminals in device detection and service discovery. If stationary servers with hotspots exist, servers typically act as application directory servers. However, device detection and service discovery is possible without such a stationary server because one of the terminals will assume the application directory server duties.

**[0024]** The disclosed invention assigns an identifier to each application placed under control. In one embodiment, the identifier is a non-unique identifier that abstractly identifies the application. In another embodiment, the identifier specifies a function that the application performs. In another embodiment, the identifier specifies a communication protocol that the application uses to communicate. Thus, the identifier may indicate that several occurrences of an application each occurrence authored in a different computer language, or targeted to run on a different hardware platform or fulfill a different application role may be considered to be the same because they can interoperate and fulfill the same function. However, in yet another embodiment, the identifier is a unique identifier that identifies the application.

**[0025]** Figure 2A is a block diagram that illustrates the hardware and software components comprising server 110 shown in Figure 1, in accordance with one embodiment of the present invention. Server 110 is a general-purpose wireless device. Bus 200 is a

communication medium that connects keypad 201, display 202, central processing unit (CPU) 203, and radio frequency (RF) adapter 204 to memory 210. RF adapter 204 connects via a wireless link to terminal 120 and is the mechanism that facilitates network traffic between server 110 and terminal 120.

5 [0026] CPU 203 performs the methods of the disclosed invention by executing the sequences of operational instructions that comprise each computer program resident in, or operative on, memory 210. Memory 210 includes operating system software 211, application programs 212, and middleware software 220. Operating system software 211 controls keypad 201, display 202, RF adapter 204, and the management of memory 210. Application programs 10 212 control the interactions between a user and server 110 including a proximity security initialization program. Middleware software 220 includes an application program interface (API) 221, application directory 230, security association database 240, and connection log 245. API 221 assists an application program running on server 110 to find and communicate with a counterpart application running on terminal 120. Application directory 230 tracks, for each 15 application that is resident in each device in piconet 100, a reference to the device storing the application, an identifier for the application, the role that the application performs, and the security parameters that define the required policy configuration attributes and security services. In one embodiment, the reference to the device storing the application is the MAC address of the device. Security association database 240 stores all recent, pair-wise and group associations 20 established by the proximity security initialization program. Connection log 245 stores recent connections to server 110, such as general packet radio service (GPRS), Bluetooth, or wireless local area network (WLAN) connection. In one embodiment, middleware software 220

integrates the storage of any combination of application directory 230, security association database 240, and connection log 245.

[0027] Figure 2B is a block diagram that illustrates the hardware and software components comprising terminal 120 shown in Figure 1, in accordance with one embodiment of the present invention. Terminal 120 is a general-purpose wireless device. Bus 250 is a communication medium that connects keypad 251, display 252, CPU 253, and RF adapter 254 to memory 260. RF adapter 254 connects via a wireless link to server 110 or another terminal 120 and is the mechanism that facilitates network traffic between server 110 and terminal 120.

[0028] CPU 253 performs the methods of the disclosed invention by executing the sequences of operational instructions that comprise each computer program resident in, or operative on, memory 260. Memory 260 includes operating system software 261, application programs 262, and middleware software 270. Operating system software 261 controls keypad 251, display 252, RF adapter 254, and the management of memory 260. Application programs 262 control the interactions between a user and terminal 120 including a proximity security initialization program. Middleware software 270 includes an application program interface (API) 271, application directory 280, security association database 290, and connection log 295. API 271 assists an application program running on server 110 to find and communicate with a counterpart application running on terminal 120. Application directory 280 tracks, for each application that is resident in each device in piconet 100, a reference to the device storing the application, an identifier for the application, the role that the application performs, and the security parameters that define the required policy configuration attributes and security services.

In one embodiment, the reference to the device storing the application is the MAC address of the device. Security association database 290 stores all recent, pair-wise and group associations established by the proximity security initialization program. Connection log 295 stores recent connections to terminal 120, such as general packet radio service (GPRS), Bluetooth, or wireless  
5 local area network (WLAN) connection. In one embodiment, middleware software 270 integrates the storage of any combination of application directory 280, security association database 290, and connection log 295.

[0029] In one embodiment, the configuration of memory 210 and memory 260 is identical. In another embodiment, the configuration of memory 210 and memory 260 only  
10 includes the software necessary to perform the essential tasks of server 110 and terminal 120, respectively. For example, if terminal 120 needs to receive a general inquiry access code, but does not need to send a general inquiry access code message, only the software that receives this message will reside in memory 260.

[0030] In the disclosed invention, the distributed application directory stored in the  
15 middleware software is a database that makes it possible for a device to know something of the requirements and wishes of peer devices to which it connects. The database also contains information of local applications and their requirements. The information includes security parameters, as well as priority information, indicating importance of the application set by the user. The distributed application directory, or database, stores these security parameters and the  
20 middleware software enforces these security parameters. In one embodiment, these security parameters are stored as a bit-string where the bits allow the user to enable application-level

access control for each entry in the application. Thus, the user may set the security parameters to indicate that a specific application requires that a specific security association is present before communicating with a complementary application running on another device.

[0031] As shown in Figure 2A and Figure 2B, the security parameters are a bit-string in

5 which the first four bits identify a communication security type, the next two bits identify a required security API service, and the last two bits identify a level of security. The communication security type identifies the information security objective sought. Information security objectives include keeping information private or confidential, ensuring the integrity of the information, authenticating the identity of the parties to the communication, protecting  
10 against replay or reuse of the information, and the like. The specified security API service identifies cryptography methods for required application by obtaining the information security objective. The cryptography method includes signature services, encryption algorithms, and the like. The level of security determines the algorithm as well as the way information is collected. For example, higher-level security may require the use of certain location-limited channels when  
15 the security context is established. Other parameters that may be affected by the level of security are the validity period of the established security context or the validity of third-party information. For example, in low-level security formation group keys may well be used for channel protection in a way where pair-wise security establishment may not be needed between every possible pair in the group.

20 [0032] Middleware software 220 and 270 stores in security association database 240 or 290 all recent, pair-wise and group security associations established by a proximity security

initialization program. However, middleware software **220** and **270** only establishes the security associations between devices, not applications. Middleware software **220** and **270** is also responsible for purging records based on validity period settings and use order (e.g., when the database fills up, purging the oldest and least used associations). For example, if device D and peer P are each running application X, middleware software **220** or **270** sends a query to security association database **240** or **290** for an existing and valid security association between D and P. If security association A exists and satisfies the security parameters associated with X, security association A is used and no other security association between D and P is needed.

[0033] According to one embodiment, a security association includes fields for identifying the peer device and security parameters. The fields for identifying the peer device may specify the local device identity as seen by the peer device (i.e., external) or may specify the identity of the peer device as seen by the local device (i.e., internal). The security parameters, in addition to the security parameters shown in Figure 2A and Figure 2B, include a cryptographic digest (e.g., a thumbprint of a certificate), a public key pair, secret keys of a peer device, and a possible lifetime of key material.

[0034] Middleware software **220** and **270** may also prioritize both secure and non-secure applications. To minimize application congestion on the mobile terminal, the prioritization is concerned with runnable, automatically launching applications in the local network. The related application titled "Application Control in Peer-to-Peer Ad-Hoc Communication Networks" describes a system and method for launching and controlling non-secure application programs resident in wireless devices in a spontaneous and instant (ad-hoc) communications network. One



aspect of that system and method chooses the highest priority application and automatically launches the application if the application is “runnable” and the appropriate user-defined flags are set. The system and method disclosed herein addresses the task of prioritizing secure and non-secure, runnable applications that can be automatically launched. Thus, the system and method disclosed herein minimizes “application congestion” on a mobile terminal that includes secure and non-secure applications.

[0035] Middleware software 220 and 270 facilitates inter-application communication by hiding peer discovery, network formation, application and service discovery as well as automatic application launching. When two mobile devices meet, the devices exchange (i.e., distribute) application directory data that describes the applications and peer devices on the network. Using the application directory data, the mobile devices can launch and control application programs resident in wireless devices in a mobile ad-hoc communications network. However, communication in a secure manner requires the integration of the application directory and proximity security initialization software. For each application and terminal in the application directory, the user may set a requirement to use a secure channel, as well as additional information (e.g., the user may set a requirement that the application requires a digital signature facility from a cryptography API). Before launching an application that requires a secure channel, two proximate mobile devices first determine whether an existing security association will support the secure channel communication. If a security association already exists, the matching applications will launch and utilize the security association. If a security association does not exist, both devices will launch proximity security initialization software to use a location-limited (i.e., proximity) side channel, such as an infrared data association (IrDA) port, to

authenticate the devices and negotiate a security association. When the negotiation is complete, the matching applications launch and utilize the negotiated security association.

[0036] Figure 3A and Figure 3B are flow diagrams of an embodiment of a process for launching and controlling secure and non-secure application programs in a mobile ad-hoc communications network. The process in Figure 3A begins when a mobile device (device A) waits for a connection request from the network (step 302). A proximate mobile device (device B) enters the network and sends a connection request to device A (step 304). Device A and device B establish a connection (step 306) and exchange a list of applications and attributes (step 308). If local application state parameters have changed during the connection (step 310), device A and device B mutually update their list of applications and attributes (step 312) and the requesting one of the devices select an application from the list based on a predefined ordering (step 314). If local application state parameters have not changed during the connection (step 310), the requesting one of the devices select an application from the list based on a predefined ordering (step 314).

[0037] If the processing exhausts the list of applications (step 316), the process returns to waiting for a connection request (step 302). If the processing selects an application (step 316) and if the selected application does not require a security association (step 318), the processing of the selected application continues from step 328 as shown in Figure 3B. If the selected application requires a security association (step 318) and if security association database 240 or 290 includes a security context for the selected application (step 320), the processing of the selected application continues from step 328 as shown in Figure 3B. If security association

database 240 or 290 does not include a security context for the selected application (step 320) and if all runnable applications have not executed (step 322), the process defers the priority of the selected application (step 326) and continues from step 314 as shown in Figure 3A. If security association database 240 or 290 does not include a security context for the selected application (step 320) and if all runnable applications have executed (step 322), the process negotiates a security association for the deferred secure applications (step 324) and continues from step 314 as shown in Figure 3A.

[0038] In another embodiment, rather than defer the priority of the selected application until all runnable applications have executed (step 326), the process launches the proximity security initialization software on an as needed basis to establish a secure connection for the selected application. In yet another embodiment, the mobile device selects whether to defer the priority or launch the proximity security initialization software based on the computing performance required by the user of the mobile device.

[0039] The process in Figure 3B begins with examining the attributes associated with the selected application. If the selected application is running in device A (step 328) and running in device B (step 336), the process notifies device A and device B of the connection (step 330 and step 338) and selects the next application from the list (step 314). If the selected application is running in device A (step 328), is not running in device B (step 336), and is startable in device B (step 340), device B starts the selected application (step 342) and the process continues from step 318 as shown in Figure 3A. If the selected application is running in device A (step 328), is not running in device B (step 336), is not startable in device B (step 340), and is missing in device B

(step 344), then if device B will accept the selected application (step 346), device A transfers the selected application to device B (step 348) and the process continues from step 318 as shown in Figure 3A. If the selected application is not running in device A (step 328), but is startable in device A (step 332), the process starts the selected application in device A (step 334) and continues from step 318 as shown in Figure 3A. If the selected application is running in device A (step 328), is not running in device B (step 336), is not startable in device B (step 340), and is not missing from device B (step 344), the process continues from step 322 as shown in Figure 3A. If the selected application is not running in device A (step 328) and is not startable in device A (step 332), the process continues from step 322 as shown in Figure 3A.

10 [0040] To negotiate the security association, middleware software 220 or 270 launches proximity security initialization software. The proximity security initialization software enables two devices, such as server 110 and terminal 120, that have no prior security context to authenticate each other based on some kind of user-initiated physical authentication and in a resulting communication protocol generate a security association. There mutual authentication  
15 protocols include each user entering a common password into their device, using a location-limited channel as described in Balfanz, visual or short has mutual verification by the users, and pair-wise biometric identification (i.e., entering biometric data in the peer device that the local device authenticates).

[0041] If a security association between two peer devices does not exist, middleware  
20 software 220 or 270 for the first peer device sends a request to establish a security association between the first and the second peer device. The proximity security initialization software

resident in the first device negotiates the security association, including peer identification data, over a location-limited channel. Once negotiation of the security association is complete, the proximity security initialization software offers the location-limited channel for use to middleware software 220 or 270 and the application that requires the security association.

5 [0042] If the security association between the two peer devices exists, before an application that requires security can launch, the proximity security initialization software enforces the security policy set in application directory 230 or 280. The proximity security initialization software retrieves the correct security association from middleware 220 or 270, and configures the necessary security protocols (e.g., Bluetooth pairing, or Transport Layer  
10 Security/Internet Protocol Security). The application that requires security launches after establishment of the security services. However, if the security policy for the application requests a security application program interface (API) the proximity security initialization software also configures the required cryptographic services. In another embodiment, when critical security levels are in use, the security associations stored in middleware 220 or 270 may  
15 be protected and require user interaction (e.g., entering a password, or providing biometric data).

[0043] In another embodiment, the definitions of the security associations are application specific. This approach requires the proximity security initialization software to negotiate a specific security association for each pair-wise application that needs security according to the associated security policy. Also, the proximity security initialization software and the  
20 communication infrastructure provide support for multiplexing several security contexts over the communications channel based on the associations in use.

**[0044]** Figure 3C is a flow diagram of an embodiment of a process for reconnecting a secure application program in a mobile ad-hoc communications network. If security association database 240 or 290 does not include a security context for the selected application (step 320), the process optionally sends a request to middleware software 220 and 270 for data from connection log 245 or 295 (step 350). The process stores the data supplied in response to the request in a display list (step 352). The display list provides a user with the ability to browse the display list (step 354), view detailed data for each entry in the display list (step 356), and select an entry in the display list (step 358). If the entry selected is a previously established connection (step 360), the process continues from step 328 as shown in Figure 3B. If the entry selected is not a previously established connection (step 360), the process continues from step 322 as shown in Figure 3A.

**[0045]** Connection log 245 and 295, and security association database 240 and 290, store in a similar manner initialization parameters that describe a secure application connection. These initialization parameters include fields for identifying the device, and fields for security parameters. The fields for identifying the device include, for example, the local device identity as seen by the peer device, and the peer device identity as seen by the local device. The fields for security parameters include, for example, Cryptographic Digest such as a thumbprint of a certificate, public key of the peer device, secret keys of the peer device, and the possible lifetime of the key material. However, in contrast, connection log 245 and 295 is longer-term storage than security association database 240 and 290. For example, security association database 240 and 290 may only store the initialization parameters for the duration of the application connection and release the storage of those parameters when the user exits the application. Since

connection log 245 and 295 retains a copy of those initialization parameters for a longer period of time, the peer device can leave the ad-hoc network and upon returning to the network immediately start the application using the initialization parameters. Thus, the returning peer device need not re-establish a location-limited channel to touch the local device and begin secure  
5 communications.

[0046] Figure 4 illustrates is a diagram of a window depicting an embodiment of a graphical user interface for reconnecting a secure application program in a mobile ad-hoc communications network. The graphical user interface shown in Figure 4 is resident in terminal 120 as shown in detail in Figure 2B. Thus, like reference numbers and designations in Figures  
10 2B and 4 refer to like elements. However, a reader of this disclosure should understand that the graphical user interface might reside similarly in server 110 as shown in detail in Figure 2A.

[0047] As shown in Figure 4, window 400 resides in display 252 of terminal 120. Window 400 includes the elements comprising the graphical user interface. Bus 250 is a communication medium that connects keypad 251, display 252, CPU 253, RF adapter 254, and  
15 memory 260. Figure 4 shows display 252 and memory 260 as separate components. In another embodiment, CPU 253 stores window 400 is a display or video memory associated with display 252. However, in yet another embodiment, CPU 253 stores window 400 in a protected portion of memory 260.

[0048] Window 400 shown in Figure 4 includes title bar 410, data header 420, display  
20 list 430, scroll bar 440, and index 450. Title bar 410 identifies the title of window 400 as "Connection Log". Data header 420 identifies the title for the columns comprising each entry in

display list 430. Display list 430 includes one entry for each entry in connection log 295. If display list 430 is an empty list, there is no selected entry. If display list 430 is not an empty list, the graphical user interface will always consider one entry to be a selected entry and will display the selected entry in a format that differs visually from the display of the non-selected entries.

5 Figure 4 depicts the selected entry shown in reverse video as the entry in which "Device Name" is "Carol's Phone". Scroll bar 440 is a navigational element that provides an indication of the spatial location of the selected entry in display list 430. Scroll bar 440 includes an up arrow, a down arrow, a scroll region, and a scroll box in the scroll region. If the selected entry is the first entry in display list 430, the location of the scroll box is at the top-most portion of the scroll  
10 region. If the selected entry is the last entry in display list 430, the location of the scroll box is at the bottom-most portion of the scroll region. Otherwise, the location of the scroll box within the scroll region is proportional to the quotient of the index of the selected entry in display list 430 and the index of the last entry in display list 430, where the index of the first entry in display list 430 is one and the index of the last entry in display list 430 is equal to the number of entries in  
15 display list 430. Index 450 is another navigational element that provides an indication of the numerical location of the selected entry in display list 430. Index 450 includes two numbers separated by a slash. The number to the left of the slash is the index associated with the selected entry. The number to the right of the slash is the index associated with the last entry in display list 430 (i.e., the number of entries in display list 430).

20 [0049] Referring again to Figure 4, CPU 253 executes the appropriate instructions to cause window 400 to appear in display 252 of terminal 120. CPU 253 sends a request to middleware software 270 via bus 250 for data from connection log 295. CPU 253 executes the



appropriate instructions to store the data received in response to the request in display list 430. A user of terminal 120 may browse display list 430 shown in display 252. The user may also view detailed data for each entry in display list 430. The detailed data includes a name for the device (e.g., "Carol's Phone), a timestamp associated with the connection (e.g., October 3, 2003, 20 hours, and 42 seconds), an indication of the presence of security parameters, and a channel type for the connection (e.g., RFID). The user may also operate an input device such as keypad 251 to change the entry in display list 430 that is the selected entry, and to choose to reconnect to the secure application program associated with the selected entry. In another embodiment, the user may operate keypad 251 to display additional detailed data associated with the selected entry.

[0050] Although the disclosed embodiments describe a fully functioning system and method for launching and controlling secure and non-secure application programs in wireless devices in a mobile ad-hoc communications network, the reader should understand that other equivalent embodiments exist. Since numerous modifications and variations will occur to those who review this disclosure, the system and method for launching and controlling secure and non-secure application programs resident in wireless devices in a mobile ad-hoc communications network is not limited to the exact construction and operation illustrated and disclosed. Furthermore, the disclosed invention may be distributed in the form of a computer readable medium of instructions including recordable media such as a removable disc, a hard disk drive, random access memory, flash memory, and read-only memory, as well as transmission media such as a digital or analog communication link. Accordingly, this disclosure intends all suitable modifications and equivalents to fall within the scope of the claims.